

Corpuscular beam apparatus**Publication number:** EP0917177**Publication date:** 1999-05-19**Inventor:** FEUERBAUM HANS-PETER DR (DE); WINKLER
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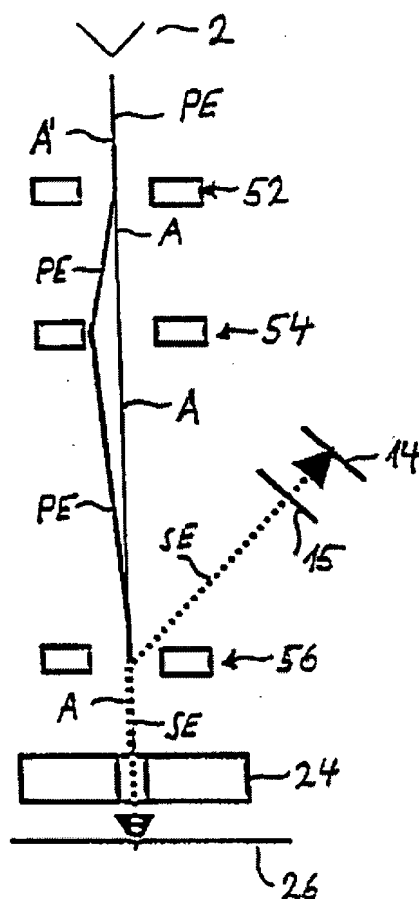
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Abstract of EP0917177

Apparatus has source (2) for producing primary corpuscles e.g. electrons, in a primary beam (PE). Particle lens (24) deflects corpuscles from the source to sample (26), and detector (14) senses secondary corpuscles from sample. Magnetic and electrostatic excursion deflectors (52,54) cause primary beam to be directed obliquely to optical axis (A), and deflector (56) below the detector guides the primary beam to optical axis.



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[0001] The invention concerns a Korpuskularstrahlgerät with a source for the production of the primary corpuscles in the primary jet, a sample, which the jet of the primary corpuscles, in a direction, hits under production of secondary corpuscles, a particle optics, in order to steer corpuscles of the source on the sample, and a detector for secondary corpuscles of the sample, arranged outside of the path of rays for the primary corpuscles.

[0002] Such Korpuskularstrahlgerät is, in particular in the form of the scanning electron microscope, generally well-known.

[0003] The detection of the secondary corpuscles, which give information to the sample on the condition which can be examined, is particularly important thereby. In addition the primary corpuscles must (mostly electrons, therefore becomes, without thereby a restriction is intended, in the following also frequently by initiating electrons and/or. Secondary electrons spoken) from the secondary corpuscles to be separated. The initiating electron jet is to be affected as little as possible, D. h., the local dissolution of the system is not to be impaired. Further the secondary electrons are to be as completely as possible seized.

[0004] With laterally attached detectors so far two systems were used. With the one D became in the sample chamber. h. between objective lens and object/sample, laterally attached from the axially running initiating electron jet, a detector. To the fact it is unfavorable that the work distance, which is the minimum clearance between objective lens and is increased object, around the secondary electron detector. In addition are a weak, sideways arranged electrical field for the diversion of the secondary electrons toward the detector necessary. Both affects negatively the smallest attainable diameter of the primary jet, which determines the local dissolution.

[0005] The detector is attached also frequently above the objective lens, in particular with objective lenses with overlaid electrostatic-magnetic fields. With a laterally attached detector the secondary electrons are then diverted by means of a vienna filter (characterizes by crossed e and B-fields) from the Z-axis to the detector. However the vienna filter requires a substantial expenditure and has also large adjusting difficulties.

[0006] The invention creates therefore a Korpuskularstrahlgerät of the indicated kind, with which with simple structure the secondary electrons can be separated surely from the initiating electrons and which dissolution of the initiating electron jet is affected as little as possible.

[0007] This reached according to invention by mechanisms in such a manner that the primary jet approaches diagonally on the Z-axis, and a deflecting system underneath the detector to in and/or. Reconduct the primary jet into the axle.

[0008] When using terms as ?below? and ?up? is always assumed the source is arranged ?up? the sample, as this is usually in practice the case.

[0009] The solution according to invention has in particular the following advantages: The diagonal direction of the primary corpuscle jet to the axle makes a deflecting system necessary. This knows however very simply, z. B. many more simply than a vienna filter, developed its. In addition, this deflecting system affects the secondary electrons, in the sense of a separation from primary corpuscles and secondary corpuscles, independently of the fact whether the deflecting system is magnetic or electrostatically trained, as down will be still implemented. By (lateral) arrangement detector in objective by deflecting system affected secondary corpuscles can this surely and without large expenditure detected, while the primary jet, considering in practice very small angles, is in particular affected around which the primary jet is diverted, practically not negatively.

[0010] Preferentially the mechanisms are carried out by an appropriate skew of the source and the particle optics before the deflecting system. If the source and the following particle optics (z. B. Condensor lens etc.) before the deflecting system around the desired angle from that source and sample connecting axle to be normally tilted, is

reached in a simple manner a diagonal impact of the primary corpuscle jet, which diagonal impact is corrected by the deflecting system according to invention with the desired effects, in particular for the secondary corpuscle jet.

[0011] Preferentially the jet direction runs at least a part of the primary corpuscle jet before the deflecting system parallel transferred to the Z-axis and is a moving mechanism for moving the primary jet from this jet direction diagonally on the Z-axis intended.

[0012] In this execution form source and following particle optics (or at least some of it) are not thus tilted, but shifts parallel, and then originally the jet parallel to the axle is diagonally hang-steered by a mechanism called here moving mechanism (from its kind from the deflecting system according to invention to differ does not have) from this parallel direction to the axle on the axle. This moving mechanism is an additional mechanism, required however still substantially less expenditure than z. B. a vienna filter and has in particular the advantage the fact that by those which by the deflecting system caused diversion straight opposite, deflection, by that diversion possibly developing picture errors (aberrations) be compensated can.

[0013] Preferred the direction of the primary jet from the source is appropriate essentially in the Z-axis, which is given by the objective axle, and exhibits the mechanisms a first moving mechanism for moving the primary jet from the axle and a second moving mechanism for the back steering of the primary jet toward the axle.

[0014] By this arrangement remains on the one hand normal structure scanning electron microscope, with which source and sample essentially receive to a straight in line, which Z-axis, are one above the other arranged. By that plans from two moving mechanisms, from which it moves the initiating electron jet from this center axle and which other one guides back these on the center axle, according to which then the deflecting system leads back the jet into the axle, can by suitable choice of the parameters (angle, distances, electrical and magnetic fields) picture errors is corrected. Furthermore a still better separation from primary and secondary corpuscle jet is possible by suitable choice of the nature of the deflection fields, as will be still implemented down.

[0015] Because in this arrangement the primary corpuscle jet above and below the total moving and/or. Deflecting system in the center line and thus the Z-axis runs, becomes also aberrations, by any off-axial process in electron-optical elements such as z. B. Condensor lens or objective would result in, suppressed.

[0016] Preferred works (with the presence of two moving mechanisms: first) moving mechanism and/or (only or second) moving mechanism electrostatically.

[0017] Preferred works (with the presence of two moving mechanisms: first) moving mechanism and/or (only or second) moving mechanism magnetically.

[0018] There is thus in principle all combinations and also overlays of moving fields conceivable, whereby some, and also some combinations have, special advantages, as will be still implemented. One becomes of course on the fact respects that the selected combinations and/or. Overlays simply to produce are and for example the complexity of a vienna filter do not reach, whose use is to be avoided with genericin accordance with-eaten equipment straight.

[0019] Preferred the deflecting system works magnetically and/or electrostatically.

[0020] During a magnetically working deflecting system a particularly good separation from secondary and primary jet arises into complementary areas. This follows from the Lorentz force law, according to which the secondary particles experience straight opposite flight direction in the deflection system a Kraft directed opposite due to their in relation to the primary particles, thus into a semi-infinite space complementary to the semi-infinite space of the initiating electron jet to be steered, in which naturally then the detector in suitable place can be arranged.

[0021] If the deflecting system is however electrostatic, the secondary corpuscles are diverted in the senkrechten semi-infinite space determined by the primary corpuscle jet. For the secondary electrons the skew angle is

however larger, since the skew angle is in reverse proportional in first approximation to the speed. From it the direction-moderate and thus spatial separation of the secondary corpuscles from the primary corpuscles results.

[0022] Particularly preferentially the first moving mechanism is magnetically, the second moving mechanism electrostatic and the deflecting system as magnetic deflecting system trained, whereby the detector for the secondary corpuscles lies above the second moving mechanism. As described by a magnetically trained deflecting system the secondary corpuscle jet is steered in to the complementary semi-infinite space defined by the primary corpuscle jet and departs thereby from this. The second (electrostatically trained) deflection system diverts the secondary corpuscle jet now still additionally in the direction, from which the primary corpuscle jet runs into this deflecting system, so that a altogether still larger separation results. Preferentially a Gegenfeldspektrometer is arranged before the detector. Also further elements can be inserted by according to invention the complete spatial separation of the secondary corpuscles possible due to the arrangement for the analysis of the secondary corpuscles, prefer a Gegenfeldspektrometer.

[0023] In the following the invention is still more near described on the basis preferential remark examples with reference to the attached designs, to which because of its clarity and clarity regarding revealing expressly one refers.

[0024] Show:

Fig. 1: A Korpuskularstrahlgerät according to invention with two moving mechanisms and the deflecting system according to invention.

Fig. 2: The equipment of the Fig. 1, with that the first moving mechanism and the deflecting system magnetically, which second moving mechanism are however electrostatically trained, and which thereby reached additional spatial separation from secondary and primary corpuscle jet.

Fig. 3: An arrangement, with which the mechanisms, which cause a diagonal approaching of the primary jet on the Z-axis, are carried out by inclining/slanting the source and a part of the following optical mechanisms.

[0025] In Fig. 1 becomes the primary corpuscle jet on the Z-axis A from the source with following particle optics, summarized under the reference symbol 2, (e.g. Cathode, modulator electrode, suction electrode, anode and condensor lens) coming shown.

[0026] The first moving mechanism 52 works magnetically and/or electrostatically and moves the jet from the Z-axis A. By ?Z-axis? that axle is understood (usually defined by the Z-axis of the objective), which the initiating electron jet without the moving and deflecting systems according to invention would follow. By the first moving mechanism 52 the jet is away-steered from the Z-axis and guided back by the second moving mechanism, which can be again magnetic and/or electrostatic, to the Z-axis A, on which it approaches therefore diagonally.

[0027] By the deflecting system 56 that becomes primary corpuscle (e.g. - electrons) to jet PE now into the Z-axis A led back and takes in the following the way, which it would have taken without the moving mechanisms 52 and 54.

[0028] The initiating electron jet is led by the objective 24 and hits in well-known way the sample 26. With the scanning electron microscope additional raster mechanisms are intended, which are not represented here.

[0029] By the impact of the primary corpuscle jet the sample 26 secondary corpuscles, for example secondary electrons or backscattered electrons, are released which are accelerated by suitable mechanisms away from the sample toward the objective and by the objective are bundled.

[0030] The secondary particles lying in the range of the Z-axis A it pass through those as magnetic mechanism trained moving mechanism 56 and after the Lorentz force law into the semi-infinite space complementary to the semi-infinite space of the initiating electrons are diverted here in which the detector 14 is accordingly so arranged

that the secondary corpuscles hit it. By the arrangement according to invention it is possible, for z. B. to arrange still another Gegenfeldspektrometer marked with 15.

[0031] In Fig. the first moving mechanism 52 is according to invention trained 2 execution form shown magnetically and the second moving mechanism 54 electrostatically, while however the deflecting system 56 is again designed as magnetic deflecting system.

[0032] Thus arises in Fig. 2 represented process of the initiating electron and of the secondary electron beam. It is to be marked that in the figures the radial dimensions and thus the jet skew angles are exaggerated largely represented for elucidation.

[0033] In addition, without restriction of the requirements according to invention, the effective beam deflections are for the sake of simplicity suggested by breaks.

[0034] In addition in all three figures the same charge sign is accepted with primary and secondary corpuscles.

[0035] In this execution form the detector is 14 already and with Fig. 1 mentioned Gegenfeldspektrometer 15 above the second moving mechanism, as represented, arranged.

[0036] Remaining conditions correspond to those the Fig. 1 and are not again described here.

[0037] In the execution form of the Fig. 3 in which same reference symbols designate same or appropriate parts, is in Fig. jet section marked 2 with 18 by appropriate skew of the units summarized under the reference symbol 2 as it were to the rear extended, whereby the moving mechanisms 52 and 54 can be let go away. This can result in a less good optical illustration in individual cases, since the correction options are missing by the moving mechanisms 52 and 54, represents the basic principle of the invention however all the purer.

Claims:

1. Korpuskularstrahlgerät (1) also

a source (2) to the production of the primary corpuscles in the primary jet (PE),
a sample (26), those the jet of the primary corpuscles, in a direction, under production of secondary corpuscles (SE), hits,
a particle optics (24), in order to steer corpuscles of the source (2) on the sample (26), and
a detector (14) for secondary corpuscles (SE) of the sample (26), arranged outside of the path of rays for the primary corpuscles,
marked through
Mechanisms (52, 54), in such a manner that the primary jet (PE) approaches diagonally on the Z-axis (A), and
a deflecting system (56) underneath the detector (14) to in and/or. Reconduct the primary jet (PE) into the Z-axis (A).

2. Korpuskularstrahlgerät according to requirement 1, by the fact characterized that the mechanisms are carried out by an appropriate skew of the source (2) and the particle optics before the deflecting system (56).

3. Korpuskularstrahlgerät according to requirement 1, characterized thereby,

that the jet direction runs at least a part of the primary corpuscle jet before the deflecting system (56) parallel-transferred to the Z-axis (A),
and through
a moving mechanism (54) to moving the primary jet from this jet direction diagonally on the Z-axis (A).

4. Korpuskularstrahlgerät according to requirement 1, by it characterized,

the fact that the direction (A') the primary jet from the source (2) essentially in the Z-axis (A) lies,
and
that the mechanisms a first moving mechanism (52), to moving the primary jet (PE) from the Z-axis (A, A'), and a second moving mechanism (54), for the back steering of the primary jet (PE) toward the Z-axis exhibit (A, A').

5. Korpuskularstrahlgerät according to requirement 3 or 4, by the fact characterized that (first) the moving mechanism (52) and/or (second) moving mechanism (54) work electrostatically.

6. Korpuskularstrahlgerät after one of the requirements 3 to 5, by the fact characterized that (first) the moving mechanism (52) and/or (second) moving mechanism (54) work magnetically.

7. Korpuskularstrahlgerät after one of the requirements 1 to 6, by the fact characterized that the deflecting system (56) works magnetically and/or electrostatically.

8. Korpuskularstrahlgerät after one of the preceding requirements, by the fact characterized that the first moving mechanism (52) magnetically, which is designed as magnetic deflecting system second moving mechanism (54) electrostatically and the deflecting system (56), whereby the detector (14) for the secondary corpuscles (SE) lies above the second (54) moving mechanism.

9. Korpuskularstrahlgerät after one of the preceding requirements, by the fact characterized that before the detector (14) a Gegenfeldspektrometer (15) is arranged.